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Species Identification of Ulmus Pollen

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Dansk sammendrag

Artsbestemmelse af Ulmus pollen

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ABSTRACT

On the basis of pore counts on modern pollen it is shown that *Ulmus glabra* Huds., *U. laevis* Pall., *U. minor* Mill. (*U. carpinifolia* G. Suchow) and *U. procera* Salisb. can be distinguished with some degree of certainty by their pollen. On the basis of fossil pollen it is shown that *Ulmus laevis* was the first elm species to immigrate into Lithuania, as has been asserted earlier, and that *Ulmus glabra* dominated the elm population in Atlantic time at the Danish localities investigated.

INTRODUCTION

That it should be possible to distinguish elm species by their pollen grains was first pointed out by SAURAMO (GROSS, 1939; SAURAMO, 1942) who says briefly that pollen grains from *Ulmus glabra* and *U. laevis* can usually be separated without difficulty on their morphology, but unfortunately he does not say how.

THOMSON (1942) states that *Ulmus laevis* has pollen grains with a more irregular form, larger pores and a coarser sculpture than pollen grains from *U. glabra.*

MONOSZON (1959) thinks that she is able to distinguish between, among others, *Ulmus foliaceae, U. glabra, U. laevis* and *U. suberosa.* The distinction is, however, not made on exact values alone, but on a combination of subjective judgment and pore measurements.

In this work it is attempted to distinguish between pollen from different elm species on the basis of pore number. As the method is statistical it is not possible to determine single pollen grains.

MATERIALS

As it is a very time-consuming task to get material, the present paper is only to be considered a provisional statement of methods and lines of approach.

It has been a problem when collecting the material to identify the species with certainty and to check the determination of the herbarium material has often been difficult, too.

The characteristic forms of the elm species are easy to recognize, but problems arise from the fact that under certain circumstances the trees assume aberrant forms, and from the fact that there is always the risk of hybrids occuring.

The most representative pollen material is that of *Ulmus glabra.* Most of these samples are from different localities in Denmark, and they should therefore chiefly represent ssp. *scabra.* Two samples from Norway, however, probably represent ssp. *montana.* Unfortunately none of the Danish samples are from natural forests. Most of the *Ulmus minor* material derives from two localities on Öland, Sweden, and so is geographically one-sided. Finally the *Ulmus laevis* material consists of herbarium specimens only.

Samples are normally taken while the trees are flowering, and this was done in some cases. However, many of the samples were taken in moss polsters in stands with only one elm species. Such a sample should mainly represent the vegetation within a range of about 30 m. (S. T. ANDERSEN, 1967). Moss polsters make it possible to take samples all year round, make it easier to collect samples, and most important, they give an expression of a local elm population not of a single tree. By investigating the population directly in a moss polster one avoids the trouble of having to study many trees from the same stand and then by statistics to find out how the population looks, and as the main purpose is to be able to compare fossil material with modern material, it is the populations which are of interest.

Ulmus laevis apparently often grows sparsely intermingled in stands of other elm species, and until now it has not been possible to get moss samples beneath this species alone.

METHODS

In order to distinguish between the three species *Ulmus glabra, U. laevis* and *U. minor* the number of pores on their pollen grains have been counted. The results (see pag. 18) have been plotted in a triangular diagram (fig. 1) with 100 per cent 4–, 5–, and 6-pored pollen grains in the corners and 0 per cent on the opposite sides. In a few instances pollen grains with less than 4 and more than 6 pores were found. These are included in the 4- and 6-pored groups respectively. *Ulmus procera* pollen is dealt with in a separate diagram (fig. 2), as the pore number variates between 5 and 7. Pores on folded grains were also counted where possible, in order to avoid any errors that might arise if grains with 6 pores are folded more easily than those with 4. Abnormal pollen grains (i. e. periporate grains, grains with irregular distribution of the pores etc.) were not counted.

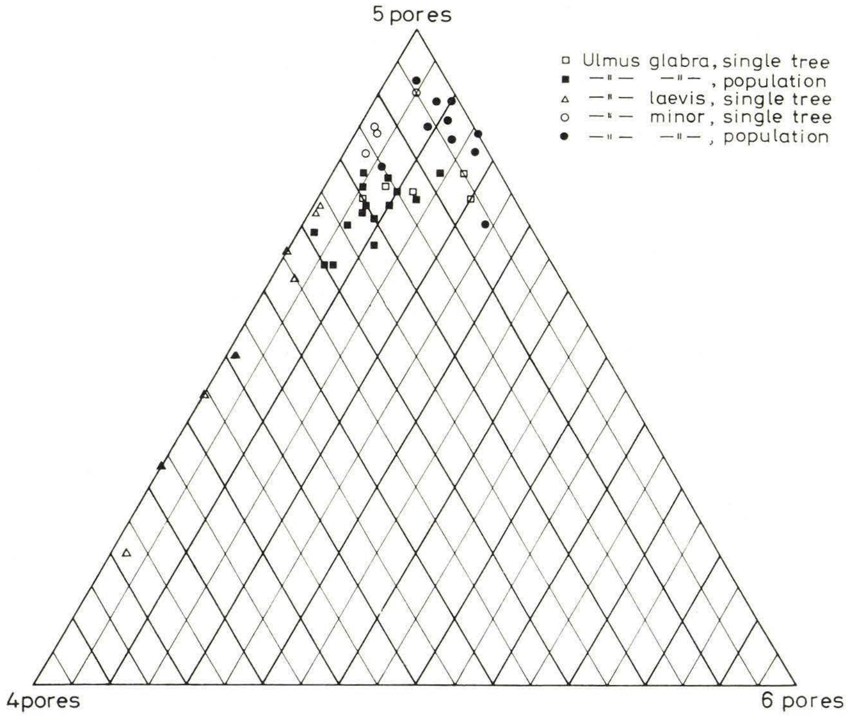

Fig. 1. Percentage distribution of *Ulmus* pollen grains by pore number in modern samples. 100 per cent in the corners and 0 per cent on the opposite sides.

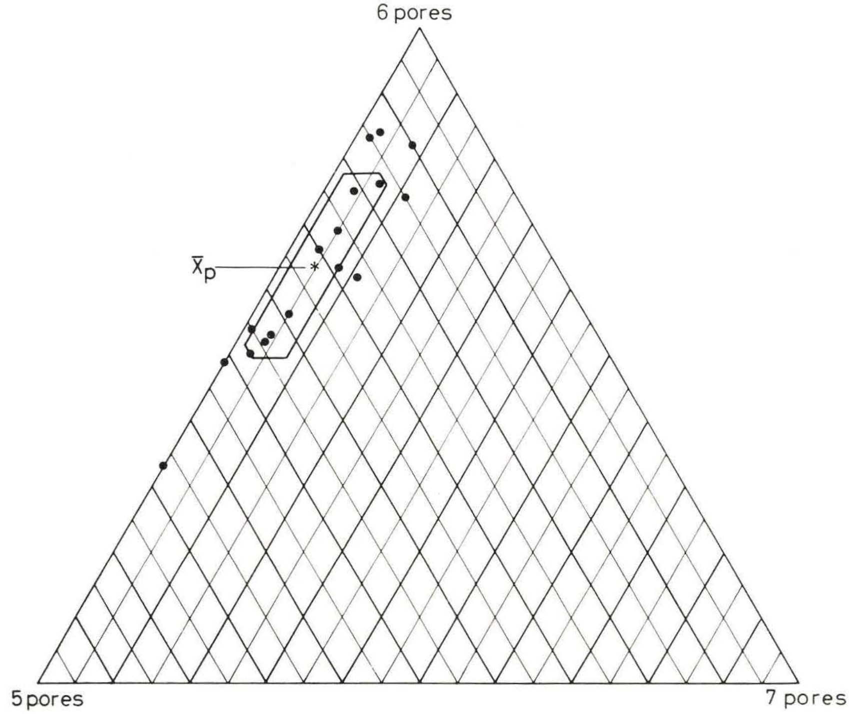

Fig. 2. Percentage distribution of *Ulmus procera* pollen grains by pore number in modern samples. 100 per cent in the corners and 0 per cent on the opposite sides. Arithmetic mean, $\bar{x}_p$, and standard deviation are shown.

Two stands of pure *Ulmus minor* had such abnormal pollen grains that it was impossible to count the pores. These were a stand at least 200 years old in Västerstads Lund, Öland, Sweden and a rather small stand on a small island, Viksö, near Lolland, Denmark. The latter has in the course of time been named both *Ulmus glabra* var. *nitida* Fr. (OSTENFELD, 1918) and *Ulmus carpinifolia* Gled. (ØDUM, 1968). However, the abormal pollen seems to show that a clone of hybrid origin might be the correct interpretation. The same explanation may apply to the stand at Västerstads Lund, Öland.

Fig. 3 shows the aritmetic mean and standard deviation of the percentages of 4-, 5-, and 6-pored pollen grains for the three species *Ulmus glabra, U. laevis* and *U. minor*. Aritmetic mean and standard deviation for *Ulmus procera* is shown on fig. 2.

DISTRIBUTION OF PORES

From the diagrams (figs. 1–3) it will be seen that though the material is limited, there is an obvious difference in the distribution of pores in the four species. However, some overlapping will be seen between *Ulmus glabra* and *U. minor* and between *Ulmus glabra* and *Ulmus laevis*. The boundary between *Ulmus glabra* and *Ulmus laevis* is still uncertain, because *Ulmus laevis* is poorly represented. *Ulmus procera* differs clearly from the others.

On the basis of the present material the following characterization of the pollen of the four species may be given.

Ulmus glabra Huds. has normally 65–80 per cent 5-pored pollen grains, 5–15 per cent 6-pored, and 10–30 per cent 4-pored.

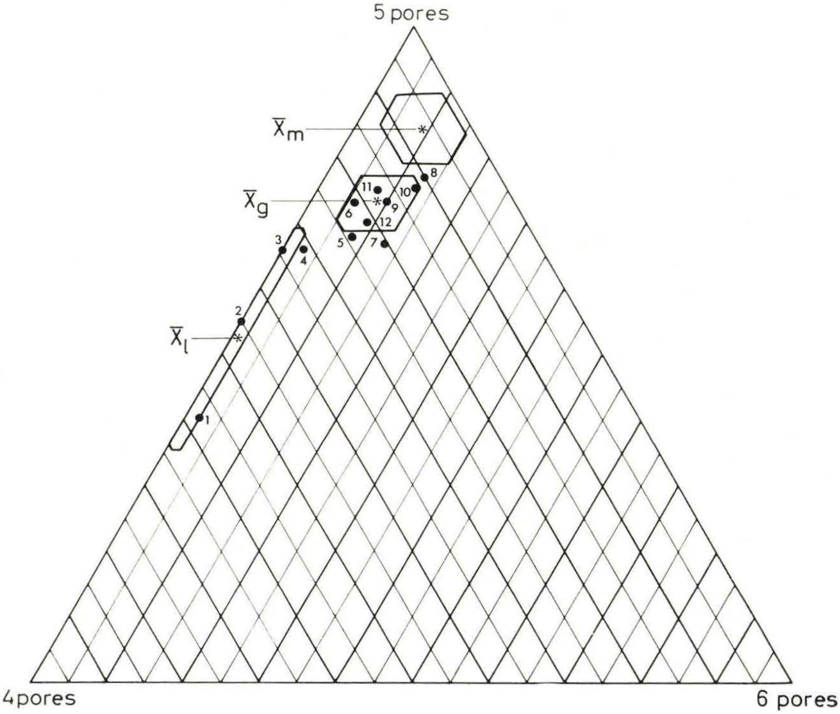

Fig. 3. Arithmetic mean and standard deviation for *Ulmus glabra*, $\bar{x}_g$, *Ulmus laevis*, $\bar{x}_l$, and *Ulmus minor*, $\bar{x}_m$, The black spots are the fossil *Ulmus* samples. The number refer to the text and the list on p. 18.

Ulmus laevis Pall. is especially characterized by the nearly total lack of 6-pored pollen grains. On the other hand there seems to be a great variation in the relation between 4- and 5-pored pollen grains. An evaluation cannot be made without further work on better and more comprehensive material.

Ulmus minor Mill. (*Ulmus carpinifolia* G. SUCHOW) normally has more than 80 per cent 5-pored pollen grains. The samples derived from single trees have a larger amount of 4-pored and less 6-pored pollen grains than those derived from moss polsters from Öland and hence it is possible that the Öland samples show a skewed distribution, and that more varied material will show a more even distribution of 4- and 6-pored grains.

Ulmus procera Salisb. is normally characterized by having mostly 6-pored pollen grains (50–85 per cent), up to about 10 per cent 7-pored, and the rest with 5 pores. The pollen grains are very variable, both in form and size, but are most frequently larger than in the other species. Forthermore, the grains are thick-walled, with a very rough sculpture.

FOSSIL ELM POPULATIONS

Even if the recent results are not complete, they are usable on fossil material. However, it must be made clear that in a fossil sample it will not be possible to distinguish a mixture of *Ulmus laevis* and *U. minor* from *Ulmus glabra* with this method. Also, it will not be possible to recognize an elm species which occurs sparsely intermingled in a stand of another elm species.

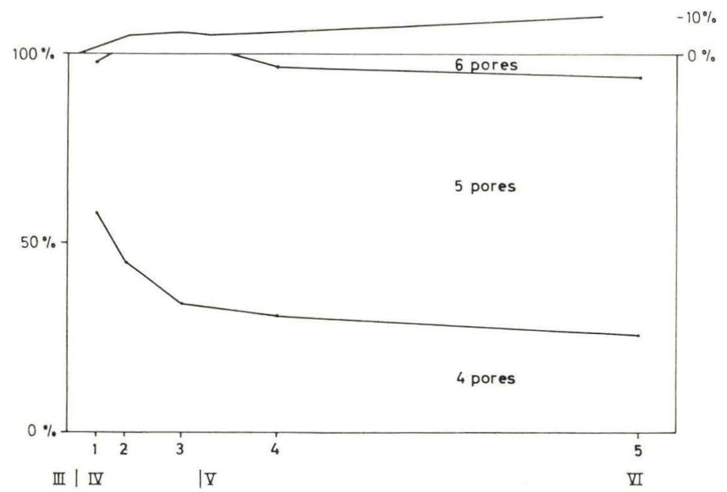

Fig. 4. Percentage distribution of *Ulmus* pollen grains by pore number in 5 fossil samples from Gusev, Lithuania arranged according to depth (sample 1 is the deepest one). *Ulmus* is shown at the top as a percentage of Σ AP. The numbers refer to the text and the list on p. 18. The Roman numerals are the Danish pollen zones.

It has been pointed out before that *Ulmus laevis* was the first elm species to immigrate into the east Baltic region (GROSS, 1939; THOMSON, 1942) and into Finland (SAURAMO, 1942). In all cases this assumption was based on pollen morphology. This has now been verified by the following investigation.

A pollen series from Lithuania, collected by KNUT FÆGRI and JOHS. IVERSEN, and analysed by S. T. ANDERSEN (unpubl.), was used in the investigation. The results are shown on the triangular diagram, fig. 3, samples 1–5 and on fig. 4. Fig. 4 shows the variation in the number of pores in pre-Boreal and Boreal time for the same five samples. At the top of fig. 4 there is a curve for *Ulmus* as a percentage of Σ AP, which shows the immigration early in zone IV, pre-Boreal, and a new expansion in zones V and VI. Sample 1 is the oldest sample, and the first in which *Ulmus* pollen is present. It can be seen that the distribution of pores corresponds to that of *Ulmus laevis*. Immediately after (sample 2) the distribution is displaced a little towards *Ulmus glabra*, and this becomes quite evident in the samples 3, 4 and 5. This indicates that *Ulmus laevis* immigrated first into Lithuania (early pre-Boreal time), and shortly after was followed by *Ulmus glabra* and/or possibly *Ulmus minor*. If *Ulmus minor* immigrated after *Ulmus laevis* one would expect that in zone VI (samples 5) there would still be a more or less equal distribution of *Ulmus laevis* and *Ulmus minor*. On the other hand, if *Ulmus glabra* immigrated after *Ulmus laevis* one would expect that *Ulmus glabra* was dominant already from early Boreal time. As *Ulmus glabra* today dominates the elm vegetation in Lithuania it may be assumed that it was this species which immigrated in late pre-Boreal time.

In order to see if something similar applied to Denmark a profile from Aamosen, Själland was chosen. Sample 6 (fig. 3) is taken from the elm immigration and is considered to belong to *Ulmus glabra*. Here, too, it could be a mixture of *Ulmus laevis* and *U. minor*, but it is not probable that both species should have immigrated at the same time. However, more analyses are necessary before anything definite can be said about the problem.

Another problem is which elm species predominated in Atlantic time.

To this end samples 7–12 (fig. 3) were chosen. They are from profiles with a clear elm decline. Five are from localities in Denmark, and one is from Switzerland (sample 12). All the samples show that the local Atlantic elm population consisted mainly of *Ulmus glabra*. It seems unlikely that the material is *Ulmus laevis* and *U. minor*. If this were so, it would not be expected that all 6 samples would fall within, or very close to the variation area of *Ulmus glabra* as they do. Furthermore two localities (Gravlev and Grane Langsö, see the list p. 18) are in deep valleys with steep sides in a moraine formation where it would be expected that *Ulmus glabra* would be dominant in relation to *Ulmus laevis* and *U. minor*.

ACKNOWLEDGEMENTS

For the inspiration to start work on this subject and for later help my thanks are due to Dr. JOHS. IVERSEN and Dr. SV. TH. ANDERSEN, Geological Survey of Denmark and to Dr. J. TROELS-SMITH, National Museum. Furthermore I should like to thank Prof. T. G. TUTIN, The University, Leicester, for help when I was collecting material from *Ulmus procera*. GILROY HENDERSON, B. Sc. has revised.

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DANSK SAMMENDRAG
ARTSBESTEMMELSE AF *ULMUS* POLLEN

Adskillelse af pollen af forskellige elmearter er behandlet af GROSS (1939), SAURAMO (1942), THOMSON (1942) og MONOSZON (1959). Adskillelsen synes dog indtil nu stadig at volde vanskeligheder.

Til adskillelse er der i dette arbejde talt porer på pollenkorn af *Ulmus glabra* Huds., *U. laevis* Pall., *U. minor* Mill. (*U. carpinifolia* G. Suchow) og *U. procera* Salisb.

Der er oftest talt porer på 100 pollenkorn i hver prøve. Prøverne består dels af herbarie materiale og dels af mospudeprøver, indsamlet i populationer med kun en elmeart. Mospuderne er langt de bedste, fordi man her direkte får et billede af elmepopulationerne.

To bevoksninger havde så abnormt pollen at det ikke lod sig tælle. Det drejer sig bl. a. om en bevoksning på Viksø ved Lolland, om hvilket det er antydet, at der måske kan være tale om en klon af hybrid oprindelse.

Det talte materiale er opført i trekantdiagrammer (fig. 1–3). På grundlag heraf gives en beskrivelse af de fire arters pollen.

Ulmus laevis er tidligere antaget at være den første elmeart der indvandrede i det østbaltiske område (GROSS, 1939, SAURAMO, 1942, THOMSON, 1942). En undersøgelse af elmepollen fra en pollenserie fra Litauen (fig. 3–4) viser tydeligt at *Ulmus laevis* indvandrede først (i præboreal tid) og formentlig efterfulgtes af *Ulmus glabra*.

Endelig viser 5 udvalgte prøver fra danske lokaliteter, at den atlantiske elmepopulation, i det mindste ved disse lokaliteter, hovedsagelig bestod af *Ulmus glabra*.

LIST OF MATERIAL

	locality	type of sample	number of pollen grains counted	number of pores per cent 4	5	6	7
Ulmus minor	Hjortholm, Samsö, Denmark	single tree	600	5	90	5	
	Mellemskoven, Falster, Denmark	– –	200	13	85	2	
	Gösslunda, Öland, Sweden	moss polster	50	4	92	4	
	– – –	– –	100	3	89	8	
	– – –	– –	300	0	84	16	
	– – –	– –	100	2	81	17	
	St. Dalby – –	– –	100	1	89	10	
	– – –	– –	100	3	86	11	
	– – –	– –	100	6	85	9	
	– – –	– –	200	4	83	13	
	– – –	– –	200	15	79	6	
	– – –	– –	100	6	70	24	
	Hungary	single tree	200	16	81	3	
	Moldavia, USSR (f. suberosa)	– –	100	13	84	3	
Ulmus glabra	Charlottenlund Skov, Denmark	moss polster	100	20	73	7	
	Kongsdal, Denmark	single tree	400	6	74	20	
	Longelse, Bondeskov, Denmark	moss polster	100	18	78	4	
	– – –	– –	100	21	72	7	
	– – –	– –	100	21	71	9	
	– – –	– –	50	24	70	6	
	– – –	– –	100	30	64	6	
	Ormö, Denmark	– –	100	15	77	8	
	– –	– –	100	15	75	10	
	Petersvärft, Denmark	single tree	500	5	78	17	
	Raahoved Skov, Denmark	moss polster	100	29	69	2	
	– – –	– –	100	29	64	7	
	Rude Skov, Denmark	– –	100	19	76	5	
	Pill Abbotsleigh, Great Britain	single tree	100	16	76	8	
	Beiarn, Nordland, Norway	surface sample	100	22	67	11	
	Sogn, Norway	– –	100	13	74	13	
	Visby, Gotland, Sweden	single tree	100	20	74	6	
	Västerstads Lund, Öland, Sweden	moss polster	100	8	78	14	
	– – – –	– –	100	17	73	10	
	Rumania	single tree	200	13	75	12	
Ulmus laevis	Vindobonam, Austria	single tree	300	35	62	3	
	Belgium	– –	100	34	66	0	
	Bøserup, Denmark	– –	100	78	20	2	
	Lolland, –	– –	100	27	72	1	
	Vigsnäs Skov, Lolland, Denmark	– –	1200	67	33	0	
	Pyhäjärvi, Finland	– –	100	49	50	1	
	Brandenburg, Germany	– –	100	56	44	0	
	Rumania	– –	200	49	50	1	
	Bjeli-Kolodesi, USSR	– –	300	26	73	1	
Ulmus procera	Knuthenborg, Denmark	single tree	100		29	63	8
	Herefordshire, Great Britain	– –	100		13	84	3
	Leicestershire, – –	– –	100		10	82	8
	– – –	– –	100		17	76	7
	– – –	– –	100		26	69	5

	locality	type of sample	number of pollen grains counted	number of pores per cent 4	5	6	7
Ulmus procera	Leicestershire, Great Britain	single tree	100		30	66	4
	– – –	– –	100		27	62	11
	– – –	– –	100		39	56	5
	– – –	– –	100		43	53	4
	– – –	– –	100		44	52	4
	– – –	– –	100		47	50	3
	– – –	– –	100		51	49	0
	– – –	– –	100		67	33	0
	Surrey, – –	– –	100		15	83	2
	– – –	– –	100		21	75	4
	– – –	– –	100		45	54	1
	Vernham Dean, – –	– –	100		15	74	11
fossil *Ulmus*	Near Gusev, Lithuania	fossil sample 1	40	58	40	2	
	– – –	– – 2	100	45	55	0	
	– – –	– – 3	100	34	66	0	
	– – –	– – 4	100	31	66	3	
	– – –	– – 5	100	26	68	6	
	Aamosen, Själland, Denmark	– – 6	78	21	73	6	
	– – –	– – 7	100	20	67	13	
	Bundsö, Jylland –	– – 8	100	10	77	13	
	Dyrholm – –	– – 9	100	17	73	10	
	Grane Langsö, Jylland, Denmark	– – 10	100	12	75	13	
	Gravlev, – –	– – 11	100	17	75	8	
	Egolzwil, Switzerland	– – 12	100	21	70	9	